

A new genus of Australian orb-weaving spider with extreme sexual size dimorphism (Araneae, Araneidae)

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Abstract

The new Australian orb-weaving spider genus *Mangrovia* in the family Araneidae Clerck, 1757 is described. It is characterised by extreme sexual size-dimorphism (eSSD) with females (total length 8–10 mm) ca. 3 to 5 times larger than males (2.5–3 mm). Whilst *Mangrovia* shares with the informal Australian ‘backobourkiine’ clade a single seta on the male pedipalp patella, the genus is probably more closely related to the ‘zealaraneines’ or associated genera. In addition to eSSD and the single patellar spine, the genus is characterised by a distinct subterminal embolus branch in males. The new genus includes two species: the type species *Mangrovia albida* (L. Koch, 1871) **comb. nov.** (= *Epeira fastidiosa* Keyserling, 1887, **new syn.**) from Queensland and *Mangrovia occidentalis* **sp. nov.** from Western Australia. Both species are apparently coastal and occur in mangroves, but also in riparian woodland. Spiders were found resting in rolled-up leaves adjacent to their orb-web.

Key Words

Backobourkiines, new combination, new species, systematics, taxonomy, zealaraneines

Introduction

Extreme sexual size dimorphism (eSSD), a phenomenon where one sex – generally the female – is at least twice as big as the other, is not a common phenomenon in spiders and mostly expressed in orb-weaving taxa (family Araneidae Clerck, 1757, incl. Nephilinae Simon, 1894 and Phonognathinae Simon, 1894) and comb-footed spiders (family Theridiidae) (Hormiga et al. 2000; Kuntner and Coddington 2020; Yu et al. 2022). There are several hypotheses explaining eSSD, for example an increase of female size due to fecundity advantage (Head 1995; Coddington et al. 1998), male dwarfism due to selection for early maturation (Gunnarson and Johnsson 1990; Vollrath and Parker 1992), or gravity advantages (Moya-Laraño et al. 2002). However, a recent review of eSSD in spiders suggests that the phenomenon is most

likely the expression of a complex of evolutionary forces, originating both in natural and sexual selection (Kuntner and Coddington 2020).

The incidence of eSSD is low within the traditional Araneinae Clerck, 1757 (sensu Scharff and Coddington 1997); at the genus level, only *Kaira* O. Pickard-Cambridge, 1889 has significantly smaller males than females (Levi 1993b; Hormiga et al. 2000), although eSSD is known to occur in other traditional ‘araneine’ genera at the species level (e.g. Piel 1996; Framenau et al. 2010). A recent multi-gene molecular phylogenetic analysis of the Araneidae did not confirm a monophyletic ‘Araneinae’; however, this study also found multiple origins (and reversals) of eSSD at the genus level in the Araneidae (Scharff et al. 2020) (see also Yu et al. (2022) for a re-analysis of the dataset with focus on *Polys* Simon, 1881 and *Cephalonotus* Simon, 1895).

Scharff et al.'s (2020) comprehensive analysis of world-wide Araneidae has transformed our understanding of araneid relationships, in particular with respect to the traditional subfamily Araneinae. The Australian species formed several well supported clades at the subfamily level, although Scharff et al. (2020) did not establish formal subfamilies for them due to their poor taxonomic knowledge and morphological circumscription. Of these groups, the 'backobourkiines' are now best known due to some recent taxonomic studies (e.g. Framenau et al. 2010, 2021a, b, 2022; Framenau 2011; Joseph and Framenau 2012). A uniting character appears to be the presence of a single macroseta on the male pedipalp patella and the median apophysis of the male pedipalp forming an arch over the radix (Scharff et al. 2020). The backobourkiines include Australian genera, such as *Acroaspis* Karsch, 1878, *Backobourkia* Framenau, Dupérré, Blackledge & Vink, 2010, *Carepalxis* L. Koch, 1872 (also known from the Nearctic), *Hortophora* Framenau & Castanheira, 2021, *Novakiella* Court & Forster, 1993, *Plebs* Joseph & Framenau, 2012 (also known in the Oriental region) and *Socca* Framenau, Castanheira & Vink, 2022. There are two currently known cases of eSSD in the backobourkiines (Scharff et al. 2020). In *Backobourkia* eSSD is expressed at the species level, as only one of three species in the genus, *B. collina* (Keyserling, 1886), is highly dimorphic (Framenau et al. 2010). In contrast, in a species-group represented by *Parawixia dehaani* (Doleschall, 1859) in Scharff et al.'s (2020) analysis – referred to as 'Araneus dehaani-group' in Yin et al. (1997) – eSSD appears to be expressed at the genus-level as a second species in this group, *Araneus albomaculatus* Yin, Wang, Xie & Peng, 1990, is also extremely size-dimorphic (Yin et al. 1997). The male of the third species in the group, *A. shunguangensis* Yin, Wang, Xie & Peng, 1990, is currently unknown. The *dehaani*-group apparently represents a new genus in the backobourkiines with *P. dehaani* clearly not belonging to *Parawixia* based on molecular data (Scharff et al. 2020).

A second well-supported group including Australian orb-weavers are the 'zealaraneines', which largely include New Zealand genera such as *Colaranea* Court & Forster, 1988, *Cryptaranea* Court & Forster, 1988 and *Zealaranea* Court & Forster, 1988, but also the Australian species *Araneus albotriangulus* (Keyserling, 1887) and *A. talipedatus* (Keyserling, 1887), both misplaced at the genus level and representing new genera (Scharff et al. 2020). Most closely related to the zealaraneines appear to be true *Araneus* Clerck, 1757, but also species in the large genus *Neoscona* Simon, 1895 (Scharff et al. 2020). Zealaraneines have no known synapomorphies, but in contrast to backobourkiines, males have two pedipalp patellar spines and the median apophysis does not form an arch over the radix (see Court and Forster 1988; figs 354–358, 360–362). There is no known case of eSSD in the zealaraneines where females are generally only slightly larger than males (Court and Forster 1988).

Our current revision of Australian orb-weaving spiders recovered a novel case of eSSD. Females of *Araneus albidus* (L. Koch, 1871), a species originally described based on a female only, are approximately three to five times larger than males. As in the *dehaani*-group, eSSD appears to act at the genus level, as a second undescribed species very similar to *A. albidus* is also extremely size-dimorphic. The male pedipalps of *A. albidus* (and the undescribed species) have only one patellar spine suggesting close affinities with the backobourkiines. However, other genitalic characters, for example the shape of the median apophysis of the male pedipalp, do not match any of the genera currently recognised in this group and these species may therefore be a zealaraneine, or not belong to any of these two well-supported indigenous Australo-Oriental groups.

The aim of this study is to describe these two species in a new genus as a working hypothesis for future phylogenetic analyses of Australian Araneidae, specifically the species of the backobourkiines and zealaraneines *sensu* Scharff et al. (2020).

Materials and methods

Descriptions and terminology follow recent publications on Australian orb-weaving spiders (e.g. Framenau et al. 2010, 2021a, b, 2022). Fresh and well-preserved specimens were used instead of historic and often poorly preserved type specimens for redescrptions. Colour patterns were described based on specimens preserved in ca. 75% ethanol. The descriptions of the male pedipalp relate to their position as a limb, i.e. a full view of the bulb with the cymbium in the background of an image is a retrolateral view as in Araneidae the cymbium is situated mesally. Our standard views of the pedipalp therefore generally show the ventral view – to illustrate the generally diagnostic median apophysis – or the dorsal view – with the tegulum in full view – as the cymbium is situated to the side in the images.

Male pedipalps were expanded by alternately submerging them for ca. 20 min in warm 10%KOH and distilled water until maximum expansion was reached. Female genitalia were dissected and then cleared in warm 10%KOH for 20 mins and transferred into lactic acid on a microscopic slide under a coverglass to further clear internal features for imaging. Measurements are given in millimetres taken at an accuracy of one tenth of a millimetre, except for eye and labium sizes measured at a hundredth of a millimetre.

Images of preserved specimens were taken in different focal planes with a Nikon D300 digital SLR camera attached to a Leica M16A stereomicroscope and combined with Auto Montage (vers. 5.02) software from Syncroscopy to increase depth of field. We used 2 Nikon R1C1 wireless speedlights instead of fibre optics to illuminate the exposures. The latter were used as guide-light for focusing. Microscopic images of cleared epigynes and

expanded pedipalps were taken in different focal planes (ca. 20–30 images) on a Leica DMC4500 digital camera mounted to a Leica M205C stereomicroscope and combined using the Leica Application Suite X, v. 3.6.0.20104. All photos were edited and mounted in the software Photoshop CC 2020.

Maps were compiled in the software package QGIS 3.22.3 ‘Białowieża’ (<https://qgis.org/en/site/>; accessed 20 February 2022). Geographic coordinates were extracted directly from original labels or the registration data as provided by the museums. When no detailed geographic information was available, localities were estimated based on Google Earth v. 7.3.4.8248 (64-bit) (<https://earth.google.com/web/>; accessed 21 February 2022).

Abbreviations

Collections

AM	Australian Museum, Sydney, Australia
NHMUK	Natural History Museum, London, United Kingdom
QM	Queensland Museum, Brisbane, Australia
WAM	Western Australian Museum, Perth, Australia
ZMH	Zoologisches Museum Hamburg, Hamburg, Germany

Morphology

AME, ALE	anterior median (lateral) eyes
PME, PLE	posterior median (lateral) eyes

Results

Taxonomy

Class Arachnida Cuvier, 1812
Order Araneae Clerck, 1757
Family Araneidae Clerck, 1757

Mangrovia gen. nov.

<http://zoobank.org/AFC772CC-2A82-4533-BF66-0317BAACE2AD>

Type-species. *Epeira albida* L. Koch, 1871, designated here.

Etymology. The genus-group name is derived from the general habitat preferences of the two species, which are often found in coastal mangroves and woodlands. The gender is feminine.

Diagnosis. Within an Australian context, *Mangrovia* gen. nov. males have only a single patellar spine on the pedipalp, a character considered a putative synapomorphy of the backobourkiines. However, *Mangrovia* gen. nov. differ considerably from members of the backobourkiines by somatic and genital morphology. Both species in the genus display eSSD with females about 3–5 times larger than males, but eSSD is absent in the backobourkiines

(with the exception of *B. collina* and species in the *dehaani*-group (sensu Yin et al. 1997)). The median apophysis in backobourkiines is elongate transverse with the base forming an arch over the radix, but it is short with an apical, spine-like projection in *Mangrovia* gen. nov. The female epigyne in *Mangrovia* gen. nov. has a terminal pocket, absent in all backobourkiines.

Mangrovia gen. nov. differs from the members of the zealaraneines as currently known (see Introduction section) by its eSSD, absent in any known zealaraneines, and the presence of only one patellar spine on the male pedipalp, whereas there are always two in zealaraneines (Court and Forster 1988). The median apophysis of zealaraneines is elongate transverse, with a variable number of spine-like protrusions, but much shorter and only with a single spine-like protrusion in *Mangrovia* gen. nov.

Outside the backobourkiines and zealaraneines, *Mangrovia* gen. nov. appears most similar to species of *Neoscona* (Berman and Levi 1971; Grasshoff 1986; Levi 1993a), in particular with respect to the male genitalia. However, eSSD is absent in any known *Neoscona* species and males of *Neoscona* have distinctly enlarged tibiae on the second leg with numerous and strong spines, often in diagnostic arrangement. *Mangrovia* gen. nov. males do not have enlarged tibiae II. In contrast to *Mangrovia* gen. nov., males in *Neoscona* have two patellar spines on the pedipalp, not one, and the embolus of *Mangrovia* gen. nov. has a subterminal side branch (e.g. Fig. 2B, C), not present in *Neoscona*. An embolus lamella is absent in *Mangrovia* gen. nov. males, but present in *Neoscona* (e.g. Levi 1993a; fig. 6).

Description. Small to medium-sized orb-weaving spiders with eSSD (TL males ca. 2.5–3 mm, females ca. 8–10 mm). Carapace (Figs 1A, 3A, 6A, 8A) rounded pear-shaped, longer than wide; colouration variable from light brown to reddish-brown with dusky edges on males. Eyes: AME largest, row of PE slightly recurved, lateral eyes almost touching, PLE separated from PME by approximately their diameter in males and by more than their diameter in females. Chelicerae paturon and fangs yellowish- to reddish-brown. Females with four promarginal teeth and three retromarginal teeth, males with three promarginal teeth and two retromarginal teeth. Labium wider than long, subtriangular, with front end bulging and white. Endites elongate-rounded, beige to light brown with antero-mesal corner shiny and white. Sternum heart-shaped, slightly longer than wide, with dark edges (Figs 1B, 3B, 6B, 8B). Legs: leg formula I > II > IV > III (males) or I > IV > II > III (females). Abdomen about as long as wide, dorsum with dark folium pattern in males, varying from uniformly grey to beige with anterior black area on females; venter black with a pair of white guanine spots. Genitalia: male pedipalp patella with a single strong spine (e.g. Fig. 1C, D); paracymbium poorly developed (Figs 1D, 2C); radix elongate (Figs 2B, 7A); no obvious stipes, possibly fused with radix (see Discussion); median apophysis oval, bearing a heavily sclerotized and acute apical

process (Figs 1C, 2A, 6C); conductor conspicuous, robust, basally sclerotised but apically fleshy (Figs 1C, 2C, 6A); terminal apophysis well-developed, somewhat spoon-shaped, not sclerotised (Figs 2A, B, 7A, B); subterminal apophysis elongate and thin (Figs 1D, 2A, C, 6D); embolus heavily sclerotized, basally inflated, then straight, thin and elongated, with subterminal short branch (Figs 2B, C, 4C, D, 7A). Epigyne base plate wider than long; scape elongate and reaching posteriorly beyond the base plate and bearing a terminal pocket; atrium rounded and very conspicuous, located almost on the border of genital area (Figs 3C–E, 8C–E); spermathecae ovoid, separated by less than their diameter; fertilisation duct basally convoluted and attaching posteriorly to spermathecae (Fig. 4A, B).

Composition. *Mangrovia albida* (L. Koch, 1871) comb. nov. and *Mangrovia occidentalis* sp. nov.

Distribution. Australia (Queensland and Western Australia) (Figs 5, 9).

***Mangrovia albida* (L. Koch, 1871) comb. nov.**

Figs 1A–D, 2A–D, 3A–E, 4A, 5

Epeira albida L. Koch 1871: 83–84, plate 7, figs 2, 2a.

Araneus albidus (L. Koch).- Rainbow 1911.- 181.

Epeira fastidiosa Keyserling 1887: 183–184, plate 16, figs 1, 1a.

New synonymy.

Araneus fastidiosus (Keyserling).- Rainbow 1916: 101, plate 21, figs 16, 17.

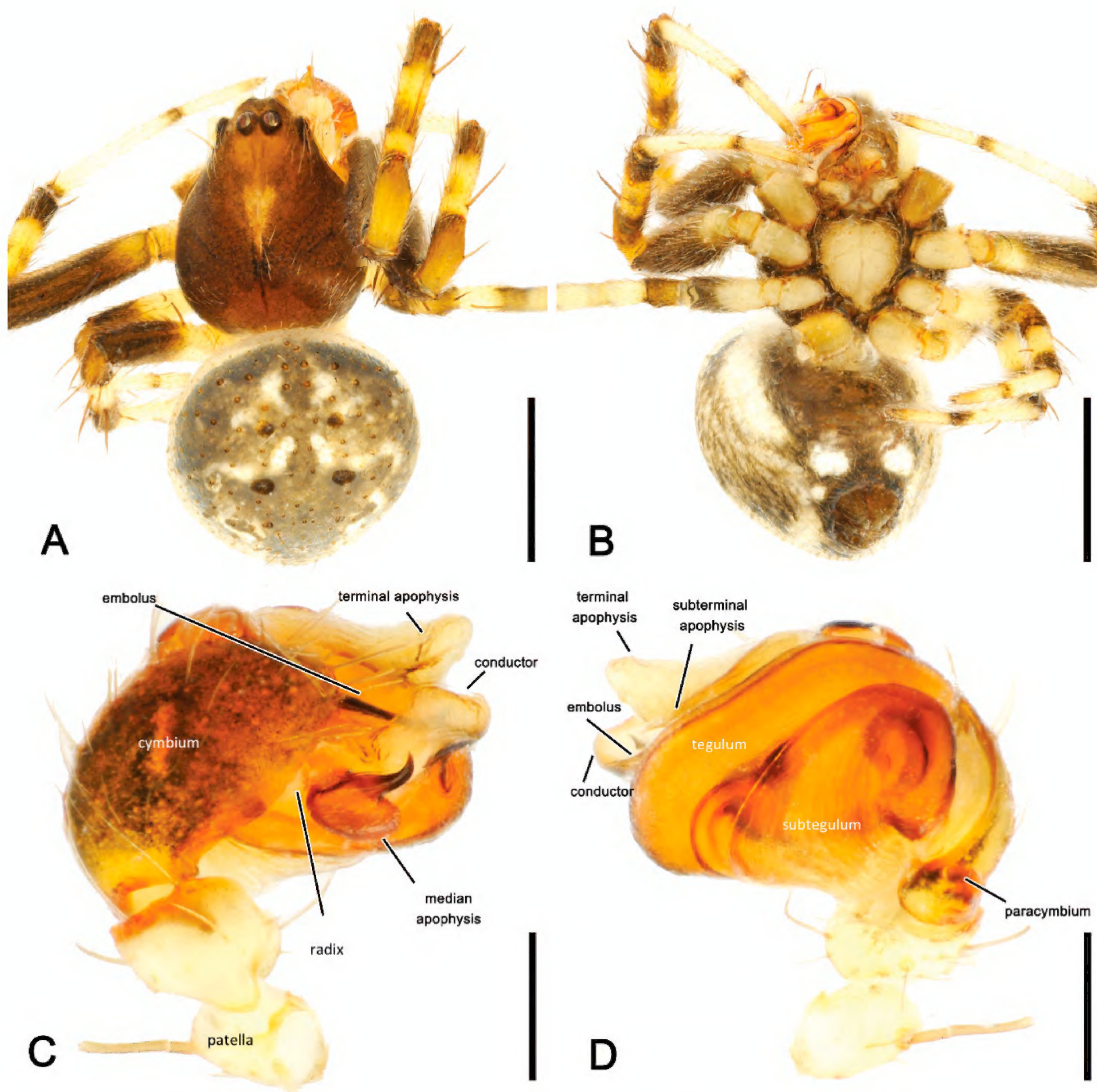


Figure 1. *Mangrovia albida* comb. nov., male (QM S67277). **A.** Habitus, dorsal view; **B.** Habitus, ventral view; **C.** Left pedipalp, ventral view; **D.** Left pedipalp, dorsal view. Scale bars: 1 mm (A, B); 0.1 mm (C, D).

Type material. *Holotype* of *Epeira albida* L. Koch 1871: female, Rockhampton, (23°23'S, 150°30'E, Queensland, Australia) (NHMUK 1915.3.5.65), examined.

Holotype of *Epeira fastidiosa* Keyserling, 1887: male Rockingham, (23°23'S, 150°30'E, Queensland, Australia) (ZMH (Rack 1961)-catalog 237), examined.

Other material examined. **AUSTRALIA: Queensland:** 1 female, Brisbane, 27°28'S, 153°01'E (AM KS.32873); 1 male, Buhot Creek, Burbank, 27°35'S, 153°10'E (QM S67277); 1 female, Bundaberg Forest, 24°52'S, 152°21'E (QM); 1 female, Baldwins Swamp (QM S25331); 1 female, Cabbage Tree Creek, 25°27'S, 150°01'E (QM); 2 female, 4 juv., Cabbage Tree Point, 25°27'S, 150°01'E

(QM); 1 female, Cabbage Tree Point, Beenleigh, 25°27'S, 150°01'E (QM); 1 female, 1 juv., Camira, 27°38'S, 152°55'E (QM); 1 male, D'Aguilar National Park, Lepidozamia Road, 27°17'S, 152°45'E (AM KS.128413); 7 females, Glasshouse Mountains, 26°53'55.3"S, 152°56'56.0"E (QM); 1 female, Karawatha Forest, 27°37'S, 153°05'E, (QM S65833); 1 male, Koah Road, 16°49'S, 145°31'E (QM S83480); 1 female, Mareeba, 17°S, 145°26'E (AM KS.32640); 1 female, Molangdool, 24°45'S, 151°33'E (AM KS.98754); 1 female, Mt Chalmers, near Rockhampton, 23°20'S, 150°40'E (QM S15531); 1 male, Rockhampton, 23°23'S, 150°30'E (NHMUK 1890.7.1.4150); 1 female, same locality

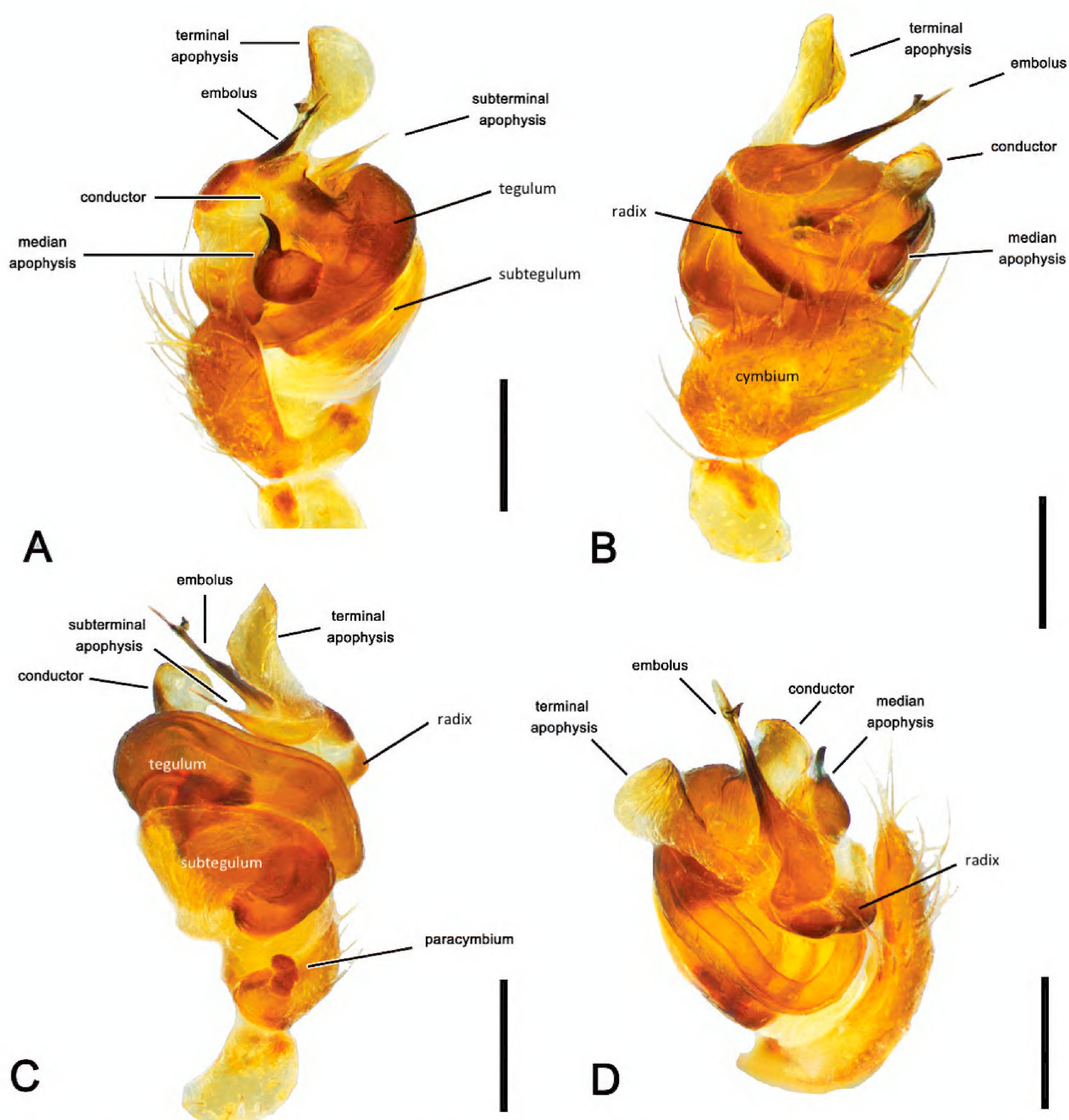


Figure 2. *Mangrovia albida* comb. nov., expanded male left pedipalp (QM S67277). **A.** Apico-ventral view; **B.** Mesal view; **C.** Retrolateral view; **D.** Dorsal view. Scale bars: 0.1 mm (A–D).

(NHMUK 1890.7.1.4171); 1 female, same locality (NHMUK 77.37); 1 immature female, same locality (ZMH Rack (1961)-catalog 218).

Diagnosis. Males *M. albida* comb. nov. can be separated from *M. occidentalis* sp. nov. by subtle differences in key pedipalp sclerites, specifically the conductor is less elongate (Figs 2B, 7B), and the terminal apophysis is less bent apically (Figs 1C, 6C). In addition, the subterminal branch of the embolus appears larger in *M. albida* comb. nov. than in *M. occidentalis* sp. nov. (Figs 2B, 7A). Females of *M. albida* comb. nov. are distinguished from those of *M. occidentalis* sp. nov. by the shorter scape and its wider tip (scape longer and thinner with thinner tip in *M. occidentalis* sp. nov.) (Figs 3C, 8C).

Description. *Male* (based on QM S67277): Total length: 2.8. Carapace (Fig. 1A) 1.4 long, 1.2 wide; dark brown, lighter in cephalic area. Eyes diameter AME 0.14, ALE 0.07, PME 0.10, PLE 0.07; row of eyes: AME 0.38, PME 0.29, PLE 0.65. Chelicerae small with paturon dark grey basally and beige apically; two promarginal teeth, the apical larger, three retromarginal teeth of similar size. Legs (Fig. 1A, B) yellow-brown with distinct dark brown annulations. Leg formula I > II > IV > III; length of segments (femur + patella + tibia + metatarsus + tarsus = total length): I – 1.6 + 0.6 + 1.0 + 1.0 + 0.6 = 4.8, II – 1.3 + 0.5 + 0.9 + 0.9 + 0.5 = 4.1, III – 0.8 + 0.3 + 0.3 + 0.4 + 0.4 = 2.3, IV – 1.2 + 0.4 + 0.7 + 0.7 + 0.5 = 3.5. Labium and endites beige. Sternum 0.5 long, 0.4 wide, beige with dark brown contour (Fig. 1B). Abdomen (Fig. 1A, B) 1.6 long,

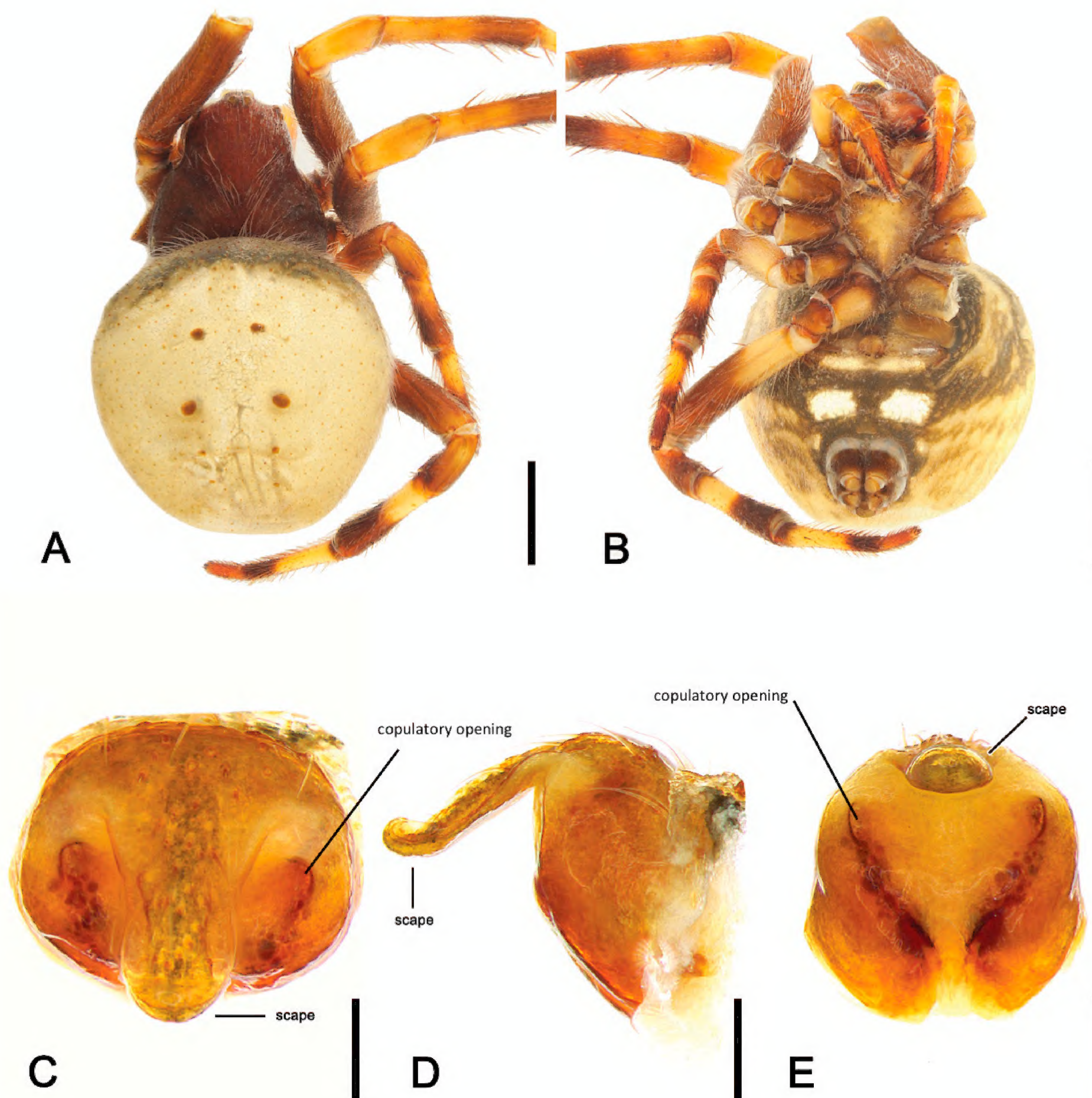


Figure 3. *Mangrovia albida* comb. nov., female (AM KS.98754). **A.** Habitus, dorsal view; **B.** Habitus, ventral view; **C.** Epigyne, ventral view; **D.** Epigyne, lateral view; **E.** Epigyne, posterior view. Scale bars: 2 mm (A, B); 0.2 mm (C–E).

1.3 wide; rounded; dorsum with instinct dark folium pattern bordered by irregular, wavy light band; two small triangular white spots anteriorly sparsely covered with long brown setae; laterally beige with greyish bands; venter dark brown with two large, rounded white spots near spinnerets. Pedipalp (Figs 1C, D, 2A–D) length of segments (femur + patella + tibia + cymbium = total length): $0.3 + 0.1 + 0.2 + 0.5 = 1.1$; cymbium broad, tegulum and subtegulum well-developed; conductor broad, basally slightly sclerotised, otherwise fleshy; median apophysis oval with an apical, slightly curved spine-like prong; radix elongate; terminal apophysis well-developed, with rounded distal portion; subterminal apophysis originating near the basis of terminal apophysis, thin and sclerotized; embolus basally inflated, otherwise thin, straight and with distinct subterminal branch.

Female (based on AM KS.98754): Total length 8.6. Carapace (Fig. 3A) 3.9 long, 3.5 wide; pear-shaped, uniformly dark reddish-brown, weak cover of long and short white setae. Eyes diameter AME 0.27, ALE 0.18, PME 0.20, PLE 0.18; row of eyes: AME 0.70, PME 0.54, PLE 1.98. Chelicerae paturon reddish brown; four promarginal teeth, apical and third largest; three retromarginal teeth of similar size. Legs colouration similar to male (Fig. 3A, B). Pedipalp length (femur + patella + tibia + tarsus = total length): $1.2 + 0.5 + 0.8 + 1.3 = 3.8$. Leg formula $1 > IV > II > III$; length of segments (femur + patella + tibia + metatarsus + tarsus = total length): I – $4.2 + 1.8 + 3.0 + 3.1 + 1.1 = 13.2$, II – $3.8 + 1.7 + 2.7 + 0.9 + 1 = 10.1$, III – $2.4 + 1.1 + 1.4 + 1.5 + 0.9 = 7.3$, IV – $3.6 + 1.6 + 2.2 + 2.3 + 0.9 = 10.6$. Labium and endites light brown. Sternum almost heart-shaped, yellowish-brown with dusky contour (Fig. 3B). Abdomen (Fig. 3A, B) 5.5 long, 4.7 wide; dorsum beige,

with black band on anterior margin; four pairs of dark brown sigillae; venter as in male, but with thin white band behind epigastric furrow area. Epigyne (Fig. 3C, D, 4A) oval, around 1.5 times wider than long; copulatory openings lateral to scape; scape broad lip with terminal pocket; spermathecae sub-spherical, almost touching; fertilisation ducts basally convoluted and attaching posteriorly to spermathecae (Fig. 4A).

Variation. Total length males 2.7–3.0 ($n = 3$), females 8.3–9.7 ($n = 5$). There is very little colour variation in both males and females, although the folium pattern in males can be very distinct.

Remarks. Rack (1961) listed the holotype of *Epeira albida* L. Koch, 1871 as her catalog number 218 in the collection of the ZMH; however, this cannot be the holotype as this specimen is an immature female and the original description and illustrations by L. Koch (1871) clearly show a mature female with fully developed epigyne. We here consider a female in the collection of the NHMUK London the holotype of *E. albida*. This specimen has the typical label handwritten by L. Koch and matches well the description in L. Koch (1871).

Keyserling (1887) described *Epeira fastidiosa* Keyserling, 1887 based on a mature male. The holotype of this species matches in all diagnostic characters the males that are here recognised as conspecific with the female *M. albida* comb. nov. We therefore consider *E. fastidiosa* a junior synonym of *M. albida* comb. nov. Similarly to *M. albida* comb. nov., the designation of the holotype of *E. fastidiosa* remains ambiguous. Rack (1961) considered a male in the ZMH (Rack (1961)-catalog no. 237) as holotype of the species, but there is also a male in the NHMUK (1890.7.1.4150) from the type locality Rockingham that could be the holotype, as part

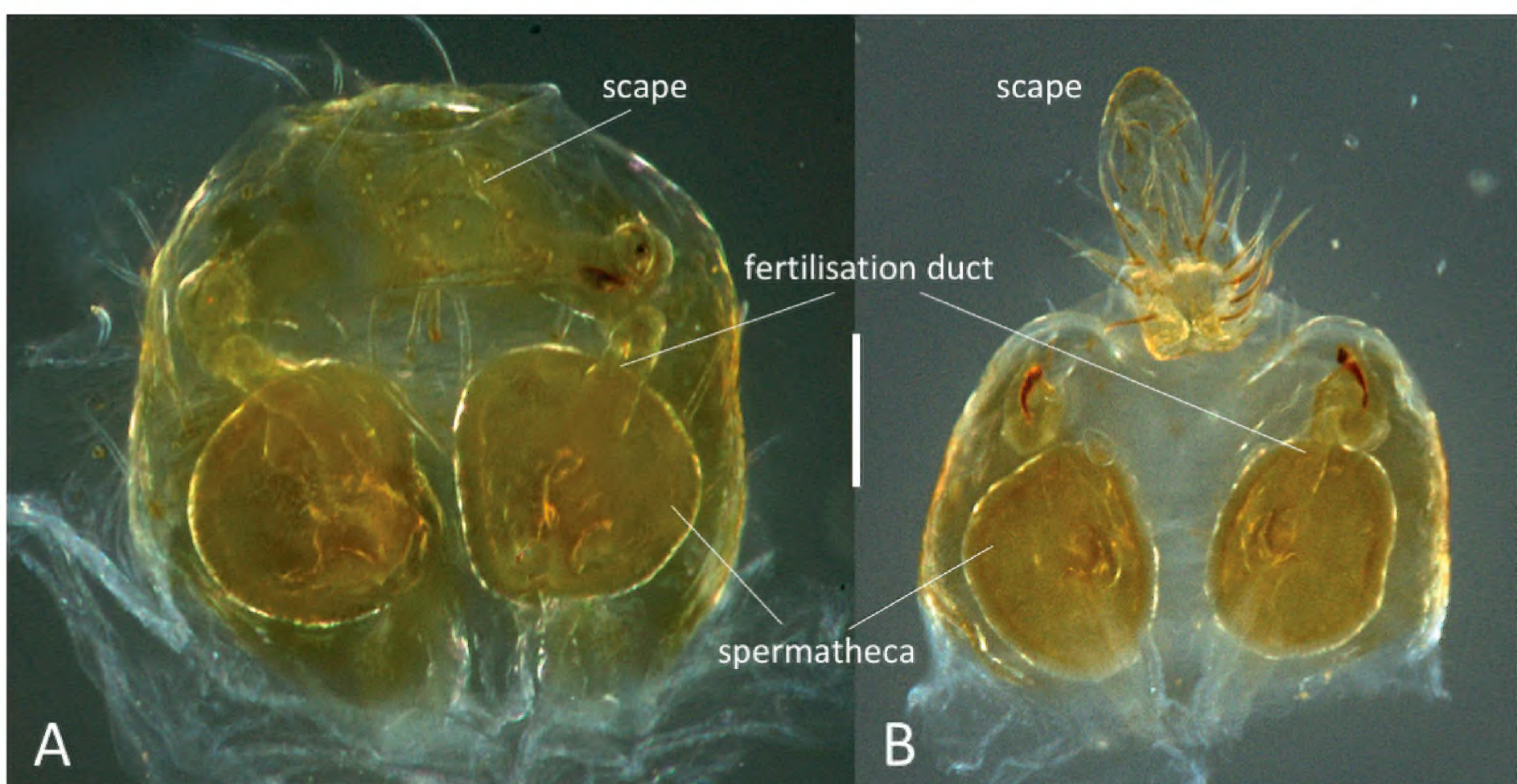


Figure 4. *Mangrovia albida* comb. nov. (AM KS.98754) and *M. occidentalis* sp. nov. (WAM T75326), cleared female epigynes, posterior view. **A.** *Mangrovia albida* comb. nov.; **B.** *M. occidentalis* sp. nov. Scale bar: 0.2 mm (**A**, **B**).

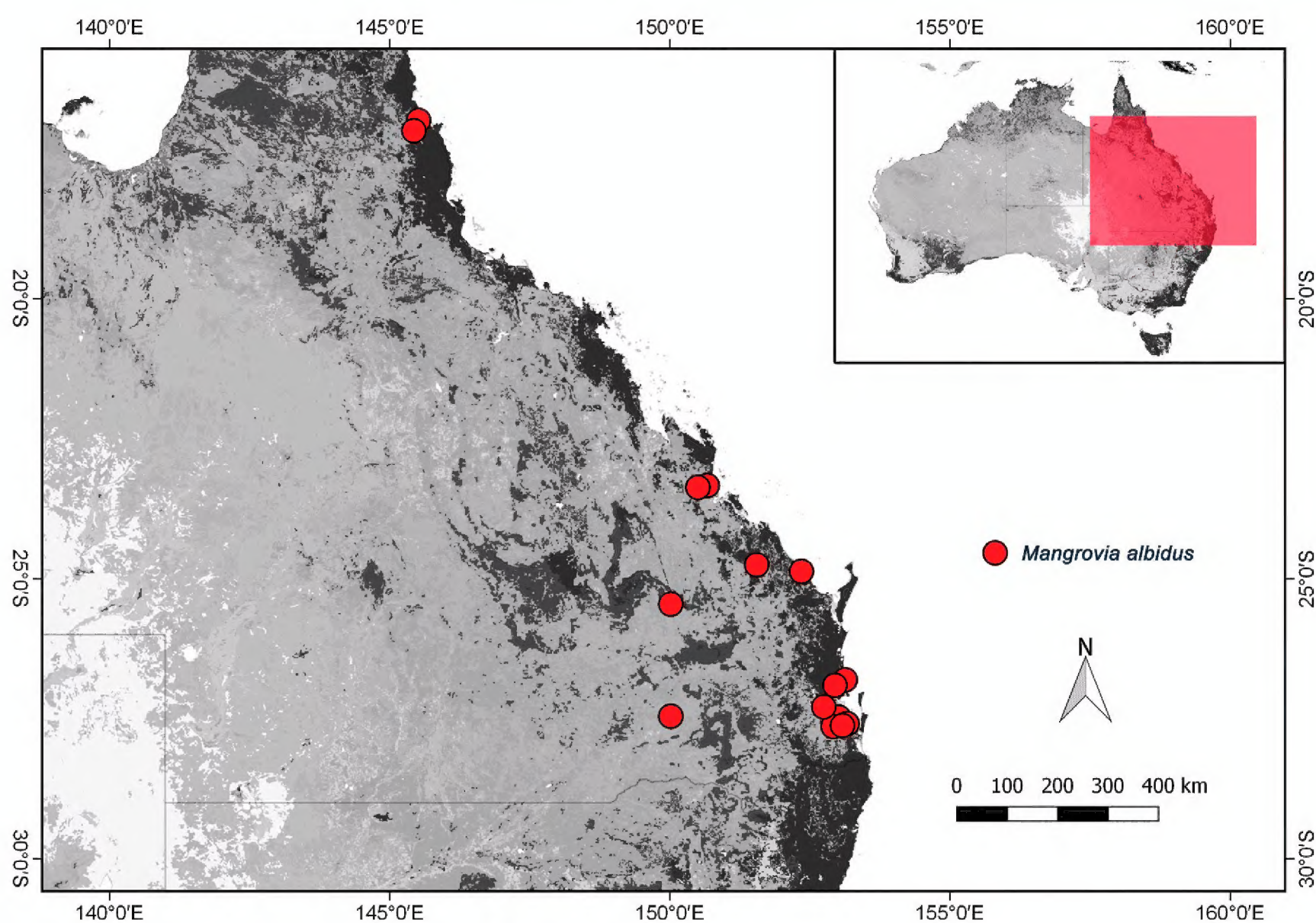


Figure 5. Distribution records of *Mangrovia albidus* comb. nov.

of the Keyserling-collection was sold to the NHMUK (J. Beccaloni, pers. comm.). Both specimens are very similar and match Keyserling's (1887) original description. We here follow Rack's (1961) initial designation of the holotype of *E. fastidiosa* to maintain consistency with previous literature.

Habitat preferences and life history. Habitat descriptions found on labels with museum specimens include 'mangroves' and 'riparian', where spiders were found in rolled leaves near the orb-web. Mature spiders were found between December and April.

Distribution. This species is only known from coastal Queensland (Fig. 5).

***Mangrovia occidentalis* sp. nov.**

<http://zoobank.org/7985F3FE-1B1E-479D-82EC-5E4BAC183D7F>

Figs 4B, 6A–D, 7A, B, 8A–E, 9

Type material. *Holotype* male, Cape Range National Park, Yardie Creek (22°20'S, 113°48'E, Western Australia, Australia), 7 July 1987, B. Y. Main (WAM T77397).

Etymology. The specific epithet is a Latin adjective in apposition – *occidentalis* – meaning western, and it refers to its distribution that is limited to coastal Western Australia.

Other material examined. **AUSTRALIA: Western Australia:** 1 female, Bay of Rest, 22°18'S, 114°08'E (WAM T75793); 1 female, same locality (WAM T75827); 1 female, 1 juv., Cape Range, 22°10'S, 114°E (AM KS.62723); 3 juv., Cape Range National Park, Yardie Creek, 22°20'S,

113°48'E (WAM T157108); 1 female, same locality (WAM T75322); 1 female, same locality (WAM T75326); 1 female with eggsac, same locality (WAM T115115); 1 female, same locality (WAM T75327); 1 female, Cooke Point, Port Headland, 20°19'S, 118°36'E (WAM T75325); 2 females, Faure Island, North, 25°48'S, 113°53'E (WAM T67857); 3 females, Faure Island, West, 25°52'S, 113°53'E (WAM T67854); 1 female, same locality (WAM T67855); 1 female, same locality (WAM T67856); 1 female, Karratha, NW airport, 20°44'S, 116°51'E (WAM T75840); 1 female, King Sound, Derby Jetty, 16°49'S, 123°28'E (WAM T75777).

Diagnosis. See above for *Mangrovia albidus* comb. nov.

Description. *Male* (based on holotype, WAM T77397): Total length 2.2. Carapace (Fig. 6A) 1.0 long, 0.9 wide; light brown with darker lateral flanks; few white setae. Eyes diameter AME 0.09, ALE 0.05, PME 0.08, PLE 0.05; row of eyes: AME 0.29, PME 0.22, PLE 0.50. Chelicerae paturon dark grey; two promarginal teeth, the apical slightly larger, three retromarginal teeth of similar size. Legs (Fig. 6A, B) beige with distal parts of femora, tibiae and patellae brown. Leg formula I > II > IV > III; length of segments (femur + patella + tibia + metatarsus + tarsus = total length): I – 1.0 + 0.4 + 0.8 + 0.7 + 0.4 = 3.3, II – 0.9 + 0.3 + 0.6 + 0.9 + 0.4 = 3.1, III – 0.6 + 0.2 + 0.3 + 0.3 + 0.3 = 1.7, IV – 0.8 + 0.3 + 0.5 + 0.5 + 0.4 = 2.5. Labium and endites beige. Sternum (Fig. 6B) heart-shaped, yellowish brown, with darker contour. Abdomen (Fig. 6A, B) 1.1 long, 1.2 wide; olive-grey with indistinct darker folium pattern; laterally yellowish-brown; ventral olive-brown, four irregular white guanine spots. Pedipalp (Figs 6C, D, 7A, B) length of segments (femur

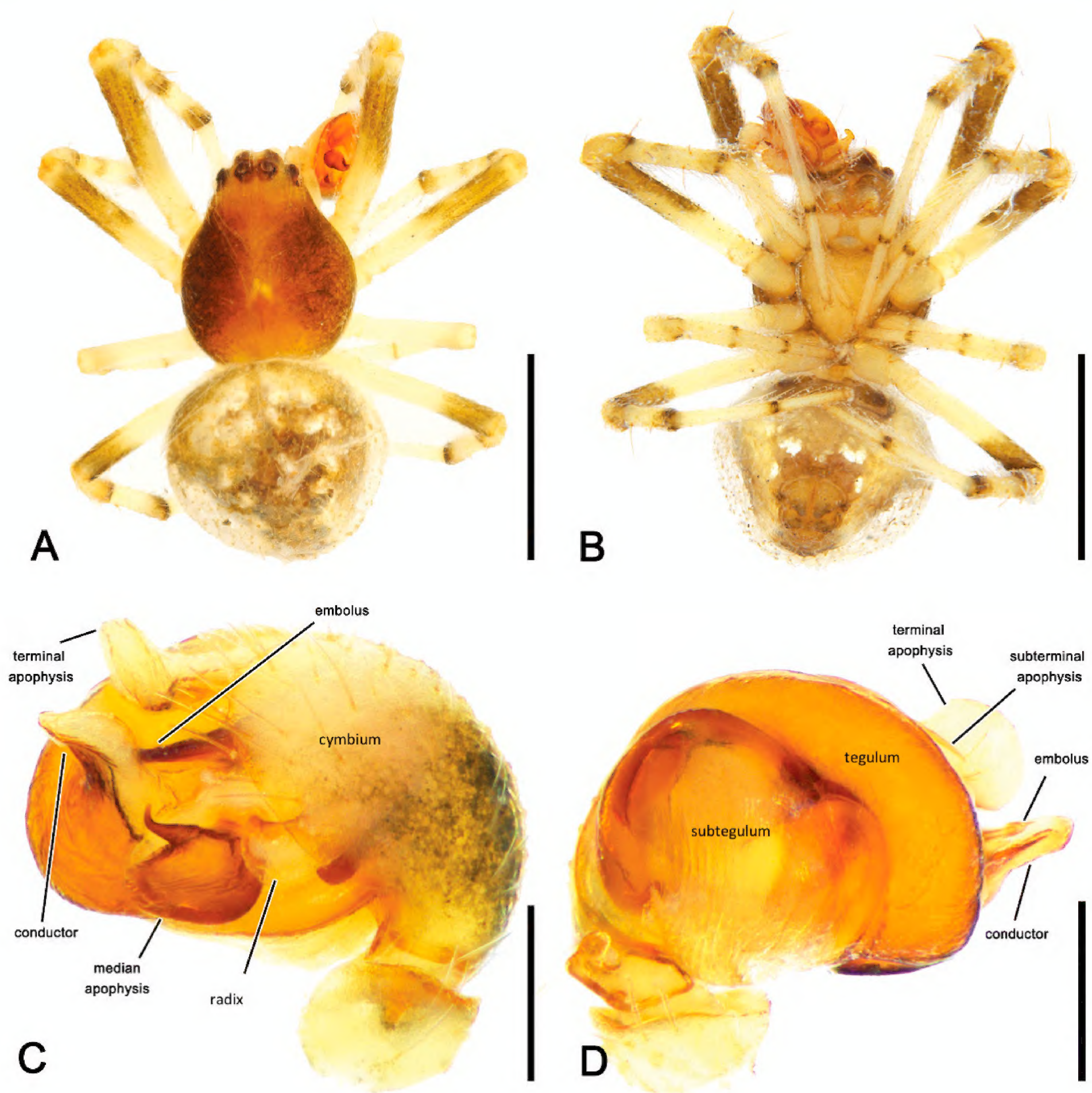


Figure 6. *Mangrovia occidentalis* sp. nov., male (WAM T77397). **A.** Habitus, dorsal view; **B.** Habitus, ventral view; **C.** Right pedipalp, ventral view; **D.** Right pedipalp, dorsal view. Scale bars: 1 mm (**A**, **B**); 0.1 mm (**C**, **D**).

+ patella + tibia + cymbium = total length): $0.2 + 0.1 + 0.2 + 0.4 = 0.9$; cymbium broad, tegulum and subtegulum well-developed; conductor broadly elongate, basally slightly sclerotised, otherwise fleshy; median apophysis oval with an apical, slightly curved spine-like prong; radix elongate; terminal apophysis well-developed, with rounded distal portion, bent apically; subterminal apophysis originating near the basis of terminal apophysis, thin and sclerotized; embolus basally inflated, otherwise thin, straight and with small subterminal branch.

Female (based on WAM T75326): Total length 10.8. Carapace (Fig. 8A) 3.8 long, 3.6 wide; pear-shaped, uniformly reddish-brown; few white setae. Eyes diameter AME 0.25, ALE 0.16, PME 0.18, PLE 0.16; row of

eyes: AME 0.65, PME 0.47, PLE 1.64. Chelicerae reddish-brown; four promarginal teeth, second basal largest; three retromarginal teeth of similar size. Legs (Fig. 8A, B) reddish-brown. Pedipalp length (femur + patella + tibia + tarsus = total length): $1.2 + 0.6 + 0.9 + 1.5 = 4.2$. Leg formula $I > IV > II > III$; length of segments (femur + patella + tibia + metatarsus + tarsus = total length): I – $4.6 + 2.1 + 3.5 + 3.4 + 1.1 = 14.7$, II – $4.0 + 1.8 + 3.1 + 0.9 + 1.0 = 10.8$, III – $2.5 + 1.2 + 1.5 + 1.6 + 0.8 = 7.6$, IV – $3.8 + 1.6 + 2.3 + 2.9 + 0.9 = 11.5$. Labium and endites reddish-browns. Sternum (Fig. 8B) heart-shaped, reddish-brown with two small lighter patches along the median line. Abdomen (Fig. 8A, B) 6.5 long, 6.3 wide; dorsally beige, with a black band along anterior margin; four pairs of dark brown

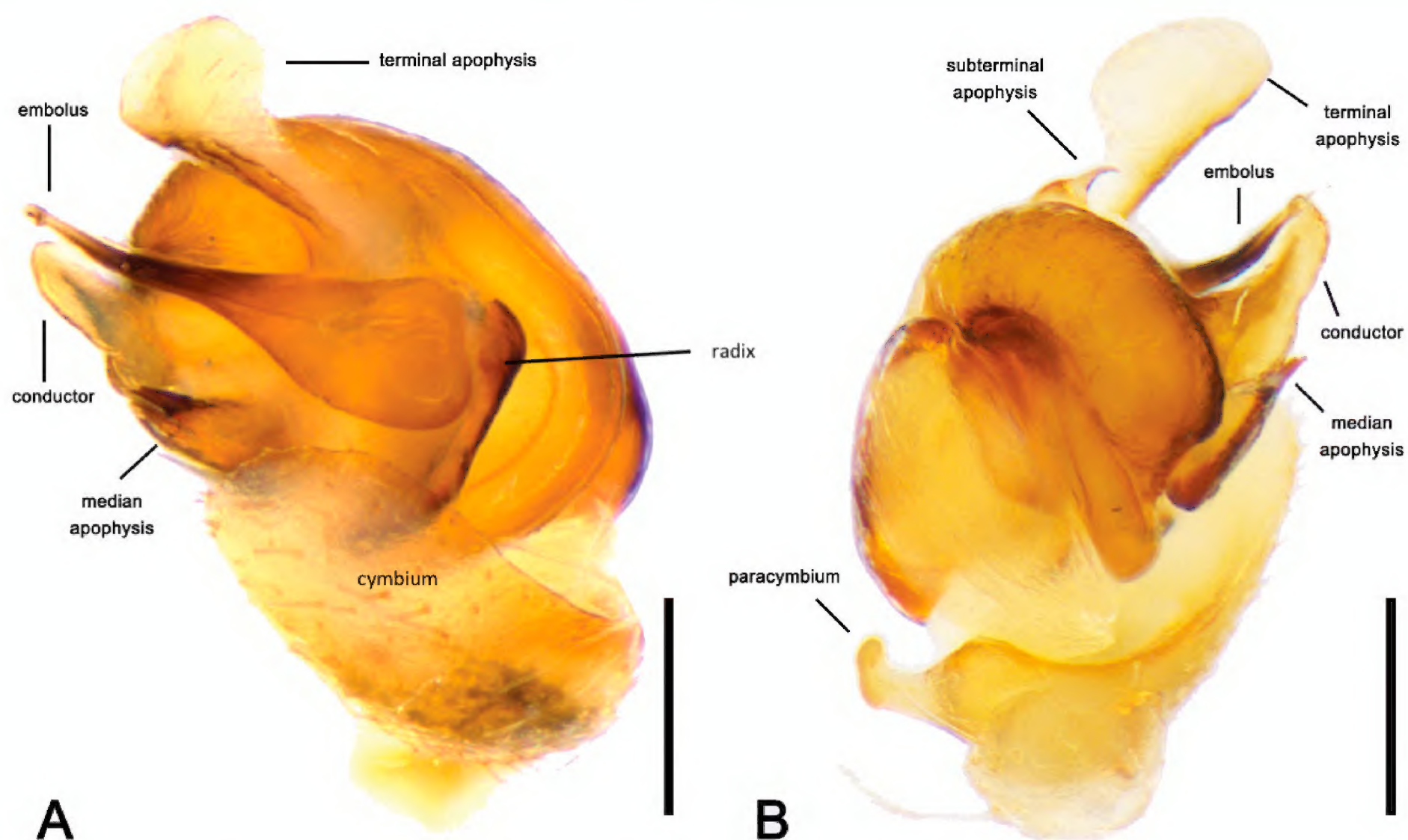


Figure 7. *Mangrovia occidentalis* sp. nov., expanded right left pedipalp (WAM T77397). **A.** Apico-dorsal view; **B.** Mesal view. Scale bars: 0.1 mm (**A**, **B**).

sigillae; venter olive-brown, with transverse guanine band posterior of epigastric furrow, somewhat lighter anterior of spinnerets and two small white spot antero-lateral of spinnerets. Epigyne (Figs 4B, 8C–E) almost twice as wide as long, copulatory openings laterally of scape; scape almost twice as long as epigyne plate, narrow, basally and apically wider, and with terminal pocket. Spermathecae ovoid; fertilisation ducts basally convoluted and attaching posteriorly to spermathecae (Fig. 4B).

Variation. Male only known from holotype; the spine on the median apophysis of the left pedipalp was broken off, therefore the right pedipalp is illustrated here. Female total length 8.7–10.6 (n = 8); there was little colour variation in females although the abdomen venter showed distinct white guanine spots in most specimens.

Habitat preferences and life history. Collection data on labels with museum specimens of *M. occidentalis* sp. nov. exclusively lists ‘mangroves’ as habitat, where, similar to *M. albida* comb. nov., spiders were collected mainly from rolled leaves near the orb-web. Mature spiders were mainly collected in May, July and September with a single record in February.

Distribution. This species is only known from coastal Western Australia (Fig. 9).

Discussion

Mangrovia gen. nov. males have a single patellar spine on the male pedipalp, a character that was noted by Scharff et al. (2020) to occur in all backobourkiines, an

Australasian clade in the analysis. This character was earlier recognised as taxonomically informative when employed in a study of Chinese araneids to key out two groups combined, species previous listed in *Zilla* C.L. Koch, 1834 (now all recognised as belonging to *Plebs* Joseph and Framenau, 2012) and the *dehaani*-group (Yin et al. 1997). Both *Plebs* and the *dehaani*-group have been confirmed as backobourkiines by molecular data (Scharff et al. 2020) showing that the single patellar spines can possibly serve as good diagnostic character beyond the Australian continent.

An association of *Mangrovia* gen. nov. with the backobourkiines is, however, poorly supported otherwise, as genital morphology of its two species is very unlike other representatives of this clade. The median apophysis of the male pedipalp does not form an arch over the radix as in all other backobourkiines and a basal extension of the conductor, referred to as paramedian apophysis or conductor lobe is absent (e.g. Framenau et al. 2010, 2021b; Framenau 2011). In addition, the epigyne scape has a terminal pocket, not found in any other backobourkiines, but otherwise common, for example, in members of the zealaraneines, a largely New Zealand clade (Court and Forster 1988; Scharff et al. 2020). An association of *Mangrovia* gen. nov. with zealaraneines is also more likely due to the similarities of its genitalia to *Neoscona*, a genus that was, albeit without statistical support, part of a sister group to zealaraneines and true *Araneus* combined (Scharff et al. 2020). It is therefore possible that a potential loss of a patellar spine in comparison to other zealaraneines, *Neoscona* and *Araneus* is an artefact of males becoming

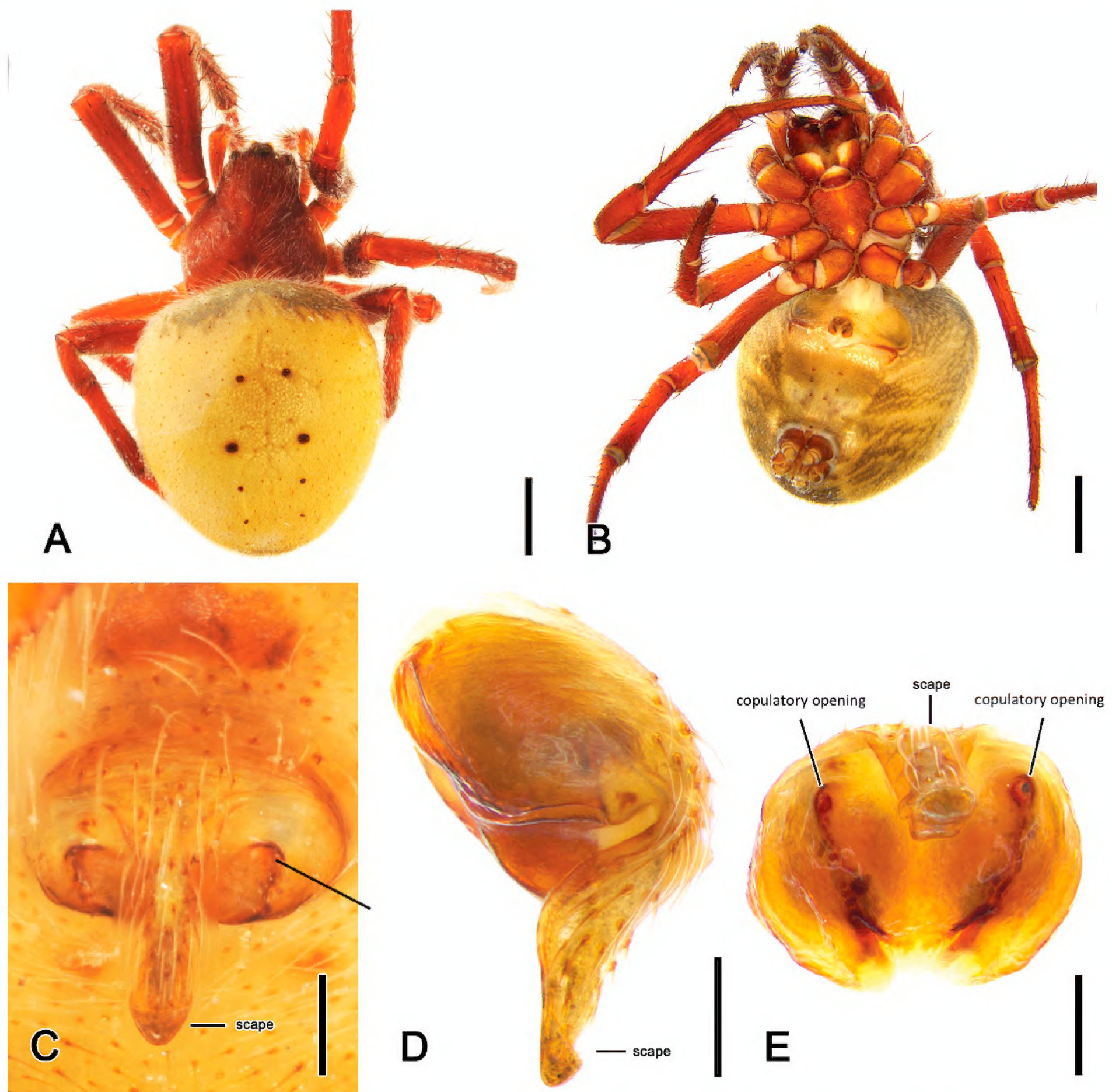


Figure 8. *Mangrovia occidentalis* sp. nov., female (WAM T75326). **A.** Habitus, dorsal view; **B.** Habitus, ventral view; **C.** Epigyne, ventral view; **D.** Epigyne, lateral view; **E.** Epigyne, posterior view. Scale bars: 2 mm (**A**, **B**); 0.2 mm (**C**–**E**).

smaller. Confidently placing *Mangrovia* gen. nov. in a phylogenetic context within the Araneidae will require, at a minimum, its inclusion into a phylogeny based on data from the molecular study by Scharff et al. (2020), although it has to be recognised that that study did not provide a fully resolved phylogenetic hypothesis of this spider family.

The pedipalp morphology of *Mangrovia* gen. nov. is very similar to that of *Neoscona*, although there are some differences, in particular in the apical section of the pedipalp, including terminal and subterminal apophyses and embolus. The *Neoscona* pedipalp also has three terminal sclerites, i.e. terminal apophysis, embolus lamella (Levi 1993a; “Terminal-Lamelle” in Grasshoff 1986) and the embolus. It is likely that the sclerite we termed subtermi-

nal apophysis is homologous to Levi’s (1993a) embolus lamella, but its shape is generally very different – and very variable – in *Neoscona* compared to the thin, needle-like structure in *Mangrovia* gen. nov. (Figs 2A, 7B). The embolus has a unique subterminal side-branch in *Mangrovia* gen. nov., the functional significance of which is unknown. ‘Capped’ emboli are not uncommon in the Araneidae (see Scharff and Coddington 1997) and are generally associated with the embolus breaking during copulation, possibly acting as mating plug in the epigyne to prevent the female from mating again. The function of the side branch of the *Mangrovia* gen. nov. embolus remains unknown.

As in *Neoscona*, the radix and stipes are either fused in *Mangrovia* gen. nov. or a stipes is absent. There

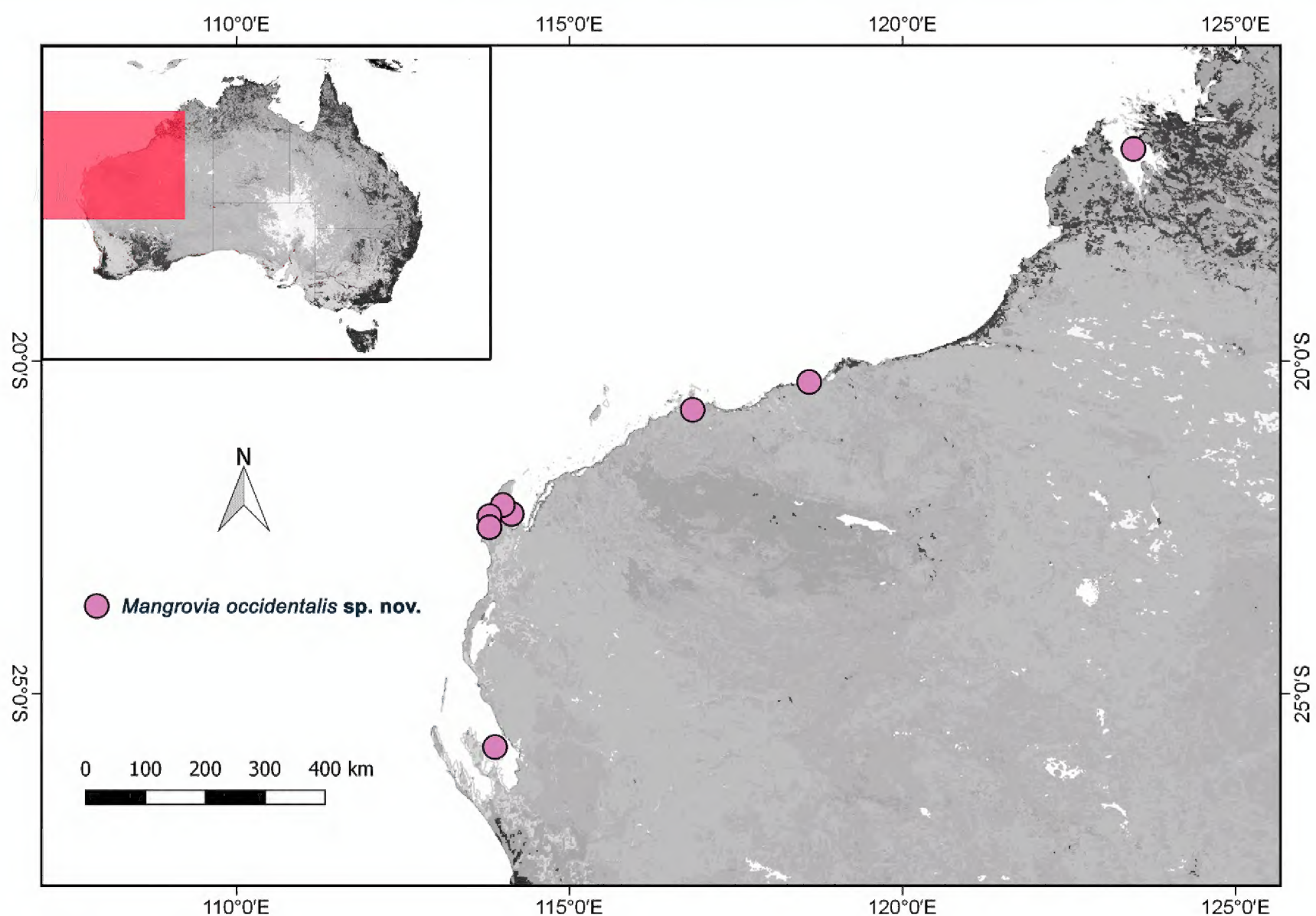


Figure 9. Distribution records of *Mangrovia occidentalis* sp. nov.

seem to be a less sclerotised short section in the radix at least in *M. albida* comb. nov. (Fig. 2C, D), which may indicate a fusion point of radix and stipes, but a similar section is not necessarily visible in *M. occidentalis* sp. nov. (Fig. 7A). Other basal pedipalp sclerites are very similar to *Neoscona*, in particular the shape of the median apophysis. Similar to many *Neoscona* (Berman and Levi 1971; Grasshoff 1986; Levi 1993a), this sclerite cannot be used to differentiate between the two *Mangrovia* gen. nov. species due to its similarity in both species. Its apical spine has likely an important function during copulation interlocking with the terminal pocket of the epigyne. Few studies have investigated genitalia during copulation in the Araneidae to explore the functional roles of the different pedipalp sclerites. But the median apophysis interlocks with the terminal pocket of the scape in *Larinia jeskovi* Marusik, 1987 (Mouginot et al. 2015).

Both *Mangrovia* gen. nov. species appear to be specialists of coastal habitats, particularly inhabiting subtropical mangroves. Here, the apparently nocturnal spiders hide in a self-constructed rolled-leaf retreat adjacent to the web during the day. In Australia, constructing a retreat from a rolled leaf has been observed in other orb-weaving spiders. Apparently similar to *Mangrovia* gen. nov., *Araneus praesignis* (L. Koch, 1872) roll a leaf of the plant that harbours the spider's web (Whyte and Anderson 2017). In contrast, *Araneus dimidiatus* (L. Koch, 1871) incorporates a dead rolled leaf into the periphery of its web where the spider hides (Framenau et al. 2014). Both species are not true *Araneus* with phylogenetic relationships poorly resolved (Scharff et al. 2020). Australian species in the

araneid subfamily Zygiellinae Wunderlich, 2004, i.e. in the genera *Artifex* Kallal & Hormiga, 2018, *Deliochus* Simon, 1894 and *Phonognatha* Simon, 1894, also suspend a dead rolled leaf in the web, but in contrast to *A. dimidiatus* it is suspended near the hub (Kallal and Hormiga 2018). It is clear that leaf-curling behaviour has evolved through different evolutionary pathways a number of times in the phylogenetic history of the Araneidae in Australia and resolving their origin requires testing with empirical data, specifically the compilation of a fully resolved phylogenetic hypothesis including all groups displaying this behaviour.

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